Chapter 2

HISTORICAL OPPORTUNITIES FOR USE

In this chapter:

- ***How often do opportunities for mechanical recovery, dispersant use, or* in situ *burning occur?***
- ***Is there a general geographic distribution of opportunities for mechanical recovery, dispersant use, or* in situ *burning?***

Analyzing the historical record of spills and potential for spills is relevant in evaluating the adequacy of current response capabilities in the United States. This chapter reviews oil spills occurring in and around U.S. waters from 1993 through 1998 to estimate historical opportunities for mechanical recovery, dispersant use, and *in situ* burning. The objectives of this chapter are twofold:

- Examine the potential application of mechanical recovery, dispersant, and *in situ* burning technologies on oil spills over the last 5 years.
- Provide a basis from which recommendations for planning requirements for these oil spill recovery technologies can be determined.

2.1 HISTORICAL OPPORTUNITIES, 1993–1998

A 1995 Marine Spill Response Corporation (MSRC) technical report, *An Analysis of Historical Opportunities for Dispersant and* In Situ *Burning Use in the Coastal Waters of the United States, Except Alaska* (Kucklick and Aurand, 1995), examines potential response activities of past oil spills. This technical report includes spills 1,000 barrels (bbls) or more from January 1973 to June 1994 and uses parameters such as oil type, weather conditions, water depth, and distance from shoreline to estimate the frequency and geographic distribution of dispersible and burnable spills. This chapter makes a similar examination of more recent spills (1993–1998) and includes information regarding historical opportunities for mechanical recovery as well.

2.1.1 Methodology

Selecting the Criteria for Evaluation. The criteria for evaluating spills between 1993 and 1998 in U.S. waters are based on those presented in the MSRC technical report (Kucklick and Aurand, 1995):

- **Mechanical recovery suitability criteria:** oil type and sea state.

- **Dispersant suitability criteria:** oil type, distance from a sensitive receptor (taken to be the nearest shoreline), water depth, and sea state.
- ***In situ* burning suitability criteria:** oil type, distance from a sensitive receptor (taken to be the nearest shoreline), and sea state.

Oil Type. Mechanical recovery, dispersability, and burnability of oil are based in part on a characteristic termed API° gravity. API° gravity is a measure of oil density that factors in the specific gravity of oil at 60°F relative to water at the same temperature. The API° gravity scale is inversely proportional to density: light oil has an API gravity of greater than 40°, and heavy oil has an API gravity of less than 10° (Killops and Killops, 1993). This becomes important in predicting whether oil is recoverable mechanically, dispersible, or burnable. Group I oils (as defined in 33 CFR 155.1020) are very light and tend to volatilize rapidly, making chemical dispersion unnecessary and (in some cases) mechanical recovery or burning dangerous. These oils typically evaporate and disperse naturally with minimal human intervention. Group V oils (as defined in 33 CFR 155.1020) are very heavy and tend to sink, making all three removal techniques ineffective.

Distance and Water Depth. Maintaining distance from a shoreline or sensitive receptor is crucial to limit negative impacts on humans and wildlife. Dispersant pre-authorization agreements currently existing around the United States specify a minimum distance from shore of 3 nautical miles (nmiles) and a minimum water depth of ~10 m (30 ft). Risk of exposure to dispersed oil typically increases in shallow water nearshore because (1) most marine life is concentrated there, and (2) there is less water volume to accommodate vertical and lateral diffusion of dispersed oil droplets. Thus, the concentrations of oil to which marine life in the water column is exposed potentially increases in the nearshore area. Oil droplets in open water diffuse rapidly, but nearshore areas may lack both the quantity and circulation of water necessary to minimize contact with marine life. For *in situ* burning, the primary concern is risk of exposure to contaminants in the smoke plume. Exposure of humans and wildlife to air contaminants released by *in situ* burning is minimized by restricting how closely to shore *in situ* burning can be conducted.

Sea State. Sea state—the final criterion—indicates how much wave action is occurring at the water surface. Wave action has significant impact on the potential effectiveness of any response option. With mechanical recovery and *in situ* burning, calm water, or low sea state, is desirable to enable effective oil containment and skimming within a boom. Dispersant use requires some agitation of surface water (higher sea state) to transport dispersed oil droplets into the water column. For this historical analysis, wind speed was taken as an indicator of sea state. A Beaufort Wind Scale and relationship to sea height chart is provided as Table 2-1 for converting wind speed to estimated sea state.

The criteria listed above are common to both the MSRC technical report (Kucklick and Aurand, 1995) and this Caps review, but differences exist between them. The most prominent difference relates to the quantity of spilled oil required for inclusion in analysis. The MSRC technical report examines spills 1,000 bbls or more over a 20-year span, while this review uses spills 1,000 gallons (gals) (approximately 24 bbls) or greater over a 5-year span.

TABLE 2-1. Beaufort Wind Scale and Sea Height Relationship.

BEAUFORT LEVEL	WIND SPEED	SEA STATE AND WAVE HEIGHT LEVELS
Force 0	Less than 1 kt	Sea like a mirror.
Force 1	1–3 kts	Wave height 0.1 m (0.25 ft). Ripples with appearance of scales, no foam crests.
Force 2	4–6 kts	Wave height 0.2–0.3 m (0.5–1 ft). Small wavelets, crests of glassy appearance, not breaking.
Force 3	7–10 kts	Wave height 0.6–1 m (2–3.5 ft). Large wavelets, crests begin to break, scattered whitecaps.
Force 4	11–16 kts	Wave height 1–1.5 m (3.5–5 ft). Small waves becoming longer, numerous whitecaps.
Force 5	17–21 kts	Wave height 2–2.5 m (6–8 ft). Moderate waves, taking longer form, many whitecaps, some spray.
Force 6	22–27 kts	Wave height 3–4 m (9.5–13.5 ft). Larger waves forming, whitecaps everywhere, more spray.
Force 7	28–33 kts	Wave height 4–5.5 m (13.5–19 ft). Sea heaps up, white foam from breaking waves begins to be blown in streaks along direction of wind.
Force 8	34–40 kts	Wave height 5.5–7.5 m (19–25 ft). Moderately high waves of greater length, edges of crests begin to break into spindrift, foam is blown in well-marked streaks.
Force 9	41–47 kts	Wave height 7–10 m (23–32 ft). High waves, sea begins to roll, dense streaks of foam along wind direction, spray may reduce visibility.
Force 10	48–55 kts	Wave height 9–12.5 m (29–41 ft). Very high waves with overhanging crests, sea takes white appearance as foam is blown in very dense streaks, rolling is heavy and shock-like, visibility is reduced.
Force 11	56–63 kts	Wave height 11.5–16 m (37–52 ft). Exceptionally high waves, sea covered with white foam patches, visibility is still more reduced.

Note: kt, knot.

Source: Adapted from U.S. National Oceanic and Atmospheric Administration (NOAA) web site (*http://www.srh.noaa.gov/gro/beautxt.htm*).

Limiting the 1993–1998 review to spills over 1,000 bbls would have narrowed the data set to fewer than 10 spills. Spills less than 1,000 gals were not examined due to the lack of detailed information (such as weather, type of oil spilled, and location) regarding the events surrounding the spills.

The primary data source for spill information used in this review is MSIS. When spill histories did not reveal sufficient detail (e.g., distances from shore or water depth), these details were determined using information from various web sites and nautical charts.

The majority of the background information on each spill was obtained through an MSIS database search of all oil spills 1,000 gals or greater occurring in the navigable waters of the United States from January 1993 to September 1998. This search collected details such as vessel name, date of incident, substance spilled, quantity spilled, and location (by latitudinal and longitudinal coordinates). The framework of each incident was completed with information obtained from narrative reports on each spill. These larger, more descriptive reports sometimes provided weather conditions and/or location details.

Culling the Spill Data Set. As shown in Figure 2-1, the MSIS database search yielded 399 spills between 1993 and 1998 (see Appendix A, Tables A-1 through A-4 for further detail). Two spills occurred in distant foreign waters (Singapore Straits and Rota, Spain), so they were removed from the analysis. Insufficient data were available for 36 spills, so these spills were eliminated from the analysis for one of the following reasons:

- No location was given (no coordinates).
- An unknown substance was discharged.
- A substance of varying or indefinite composition was discharged, such as bilge waste, drilling mud, tarballs and sludge, slurry, or waste oil.

Of the 361 remaining spills, 130 occurred in inland and Great Lakes waters, as defined in 33 CFR 155.1020 (Figure 2-2). Although it is possible to make predictions regarding the potential dispersability or burnability of oil, it is difficult to assess further whether dispersant use or *in situ* burning might have been appropriate. Furthermore, predicting the behavior of oil and dispersants in freshwater or slightly saline water makes further conclusion very speculative. Therefore, no further analysis of the suitability of dispersants and burning was done for these waters. This selective culling of spills resulted in 231 spills for analysis of historical opportunities for mechanical recovery, dispersant use, and *in situ* burning in nearshore, offshore, and open ocean areas, as defined in 33 CFR 155.1020 (Figure 2-2).

399 spills generated in MSIS database search of spills 1,000 gals and greater, 1993–1998

↓

36 spills subtracted because of insufficient information; key details absent for estimating effectiveness of oil removal techniques

↓

2 spills removed because of occurrence in distant foreign waters

↓

130 spills occurred in inland and Great Lakes waters (as defined in 33 CFR 155.1020)

↓

231 spills remaining for analysis of historical opportunity for mechanical recovery, dispersant use, and *in situ* burning in nearshore, offshore, and open ocean areas (as defined in 33 CFR 155.1020)

FIGURE 2-1. Schematic Describing the Selection of the 231 Spills for Analysis of Historical Opportunities for Mechanical Recovery, Dispersant Use, and *In Situ* Burning. Gals, gallons.

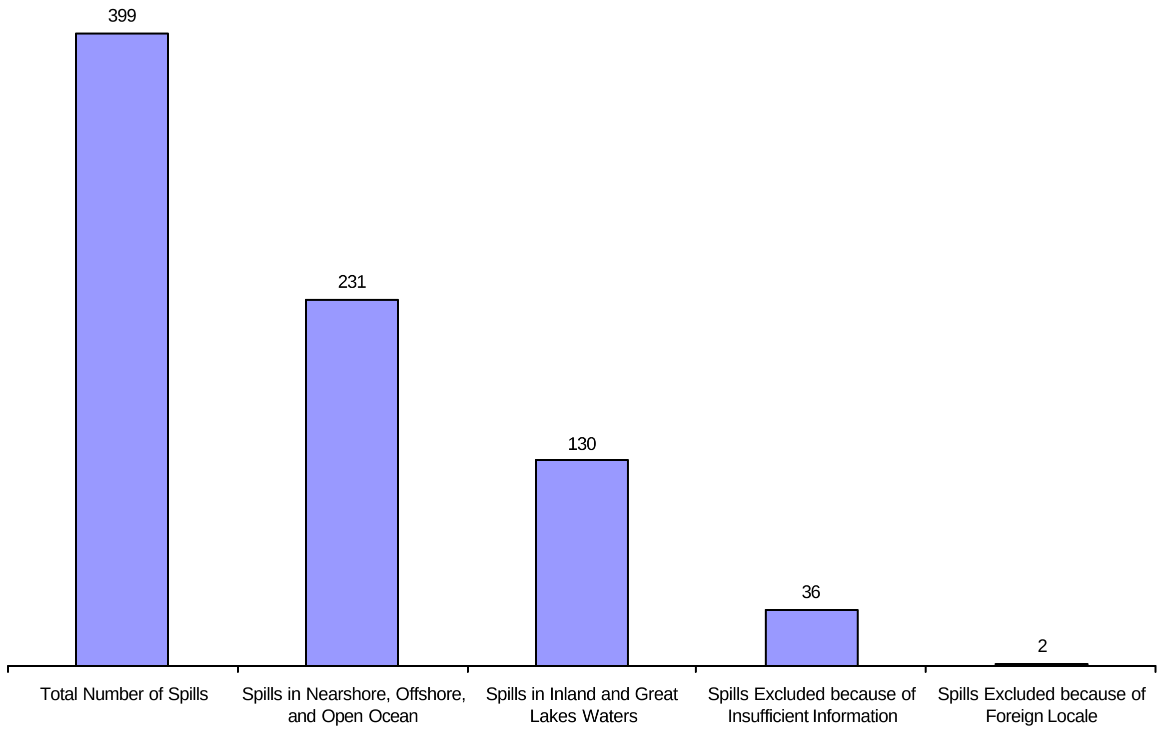

FIGURE 2-2. Distribution of 399 Oil Spills 1,000 Gallons (Gals) and Greater Generated in MSIS Database Search, 1993–1998.

Determining Distance from Shore for Each Spill. Because dispersant and *in situ* burning pre-authorization agreements usually are limited to beyond 3 nmiles from shore, an indicator of whether spills were greater than 3 nmiles from shore was necessary. Distances from shore were determined using the following process:

- **Step 1.** MSIS specifically reported distance from shore in 17 of 231 spills.
- **Step 2.** MSIS attributed 84 of the remaining 214 spills to vessel groundings. All of these spills were assumed to have occurred within ¼ nmile of shore.
- **Step 3.** The relative distance from shore for the remaining 130 spills was determined using the Census Bureau Tiger Map request web site (*http://tiger.census.gov*) or U.S. National Oceanic and Atmospheric Administration (NOAA) nautical charts. Sixty-six spills occurred less than 3 nmiles from shore, and 64 spills occurred greater than 3 nmiles from shore. Because of insufficient resolution at the ¼ nmile level, spills that occurred less than 3 nmiles from shore were assumed to have occurred between ¼ and 3 nmiles from shore for calculation purposes.

This tally resulted in a total of 84 spills that occurred less than ¼ nmile from shore, 68 spills that occurred between ¼ and 3 nmiles from shore, and 79 spills that occurred greater than 3 nmiles from shore (Figure 2-3).

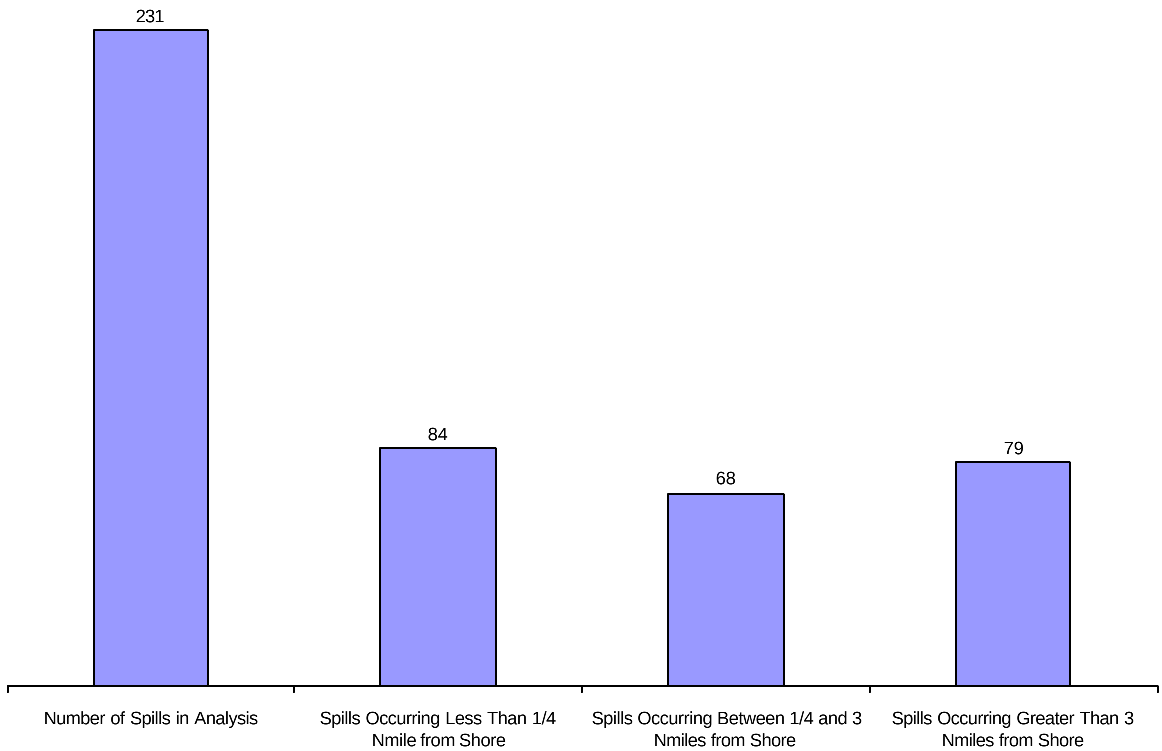

FIGURE 2-3. Distribution of 231 Oil Spills that Occurred Less Than ¼ Nautical Mile (Nmile) from Shore, Between ¼ and 3 Nmiles from Shore, and Greater Than 3 Nmiles from Shore.

Determining Weather and Sea State for Each Spill. MSIS included adequate weather and sea state data for 41 of the spills studied. For the remaining 190 spills, these data fields were populated with the aid of the National Data Buoy Center web site (*http://seaboard.ndbc.noaa.gov/data/dataindex.shtml*). This web site identifies buoys stationed throughout U.S. waters. Weather and sea conditions are recorded and archived. The buoy closest to the incident scene was assumed to have conditions representative of that area in the month of the spill. Monthly averages of wind speeds calculated over a minimum of 5 years were used to complete any weather information missing from the MSIS report.

Determining Water Depth. Determining water depth is relevant because dispersant pre-authorization agreements currently are limited to water depths greater than 10 meters. Water depth typically is not included in MSIS case histories. In this review, therefore, for most spills, U.S. Navy bathymetry data from the International Research Institute for Climate Prediction WORLDBATH web site (*http:/Ingrid.Idgo.columbia.edu/SOURCES/.WORLDBATH/.bath/*) were used to estimate water depths. Selection of the four closest coordinates bracketing the spill locations (a square of 5 minutes) generated four water depths per spill. These values were averaged to provide depth estimations at the spill scenes.

Determining Spilled Oil Characteristics. For all spills, additional data on the behavior of the particular oil in the environment were needed. Oils listed as “crude” in MSIS were listed as crude in this Caps review. All other oils in MSIS—listed as “refined” or by a more specific, refined product name—were listed as refined in this Caps review. ADIOS™ software (NOAA/HMRAD, 1994) houses a library of over 1,500 types of oil from which models can be constructed to predict how oil discharged into the environment will behave. For the purposes of this chapter, however, it was only necessary to obtain the chemical characteristics of API° gravity and pour point[1] from within the library (Table 2-2).

2.1.2 Criteria for Analysis

For each analyzed spill, potential to be mitigated effectively using mechanical recovery, dispersants, or *in situ* burning is assessed using criteria similar to those used by Kucklick and

TABLE 2-2. Chemical Characteristics Obtained from ADIOS™ Software for All Types of Oil Spilled Included in Analysis of Historical Opportunities.

TYPE OF OIL	SPECIFIC GRAVITY	API° GRAVITY	POUR POINT(°C)	POUR POINT (°F)
Alaska North Slope crude	0.89	26.8	–8	17.6
Arabian medium crude	0.88	29.5	10	50
Asphalt	0.96	15.8	N/A	N/A
Brent crude	0.83	38.2	–4.5	23.9
Crude	0.85	29.5 to 38.3	–20.55	–4.99
Diesel	0.83	39	–34 to –17.8	–29.2 to 0
Diesel no. 2	0.85	35	–23.3	–9.94
Fuel oil 1	0.8	45.4	–48 to –18	–54.4 to –0.4
Fuel oil 2	0.87	31.6	–27 to –6	–16.6 to 21.2
Fuel oil 2-D	0.85	35.3	–17.8	–0.04
Fuel oil 4	0.9	25	–29 to –5	–20.2 to 23
Fuel oil 5	0.94	19.7	–18	–0.4
Fuel oil 6	0.97	14.1	–15 to –4	5 to 24.8
Gasoline	0.73	62.4	N/A	N/A
IFO 180	0.97	14.7	–10	14
JP 4	0.78	50.8	–23 to –1	–9.4 to 30.2
JP 5	0.82	41.1	< –48	< –54.4
JP 8	0.81	43.8	N/A	N/A
Kuwait crude	0.87	30.6	–20	–4
Lubricating/hydraulic oil	0.92	22	–15 to –7	5 to 19.4
Motor oil	0.88	29	–42 to –37	–43.6 to –34.6
Naphtha	0.64	89.3	N/A	N/A
Rabbi crude	0.86	33.4	12.8	55.04
Vegetable oil	1.05	3.26	< 5	< 41

[1] Pour point is the lowest temperature at which a liquid will continue to flow.

Aurand (1995). As noted earlier, those authors only look at spills 1,000 bbls and greater. This review uses spills 1,000 gals and greater and groups spills using two geographic criteria:

- ≥ 3 nmiles from shore (*existing criteria*) because most dispersant and *in situ* burning pre-authorizations are so limited.
- ≥ ¼ nmiles from shore (*expanded criteria*) because in much of the U.S. coastal region, there is sufficient water depth and mixing action to consider both dispersants and *in situ* burning in protecting sensitive shoreline resources. Also, several regions around the country are considering extending pre-authorizations closer to shore.

The criteria used in this Caps review to analyze historical opportunities for mechanical recovery, dispersant use, and *in situ* burning are described below and summarized in Table 2-3. In addition, Table 2-4 shows the spills eliminated from the historical analysis by these criteria.

Mechanical Recovery. Open-water mechanical recovery relies primarily on containment booms, skimmers, and/or storage devices. In this review, spills were first assessed based on whether mechanical recovery was likely. Evaluation of potential use of mechanical recovery technologies was based on known physical properties of the substance spilled and sea state at the time of the spill. Mechanical recovery was not expected to be useful when wind speeds exceeded 16 knots (kts), or for discharges of substances with an API gravity greater than 45° or less than 17°. The presence or absence of ice on the open water, which potentially could hinder recovery efforts, was not taken into account.

Dispersant Use. Dispersant use is the application of some chemical agent that reduces surface tension of oil, allowing an oil slick to break into droplets that are then scattered within the water column through natural mixing (NRC, 1989). The MSRC technical report cites a study (John G. Yeager & Associates, 1986) that predicts the dispersability of crude and refined petroleum products based on API° gravity and pour point. According to that study, oils with an API gravity between 17° and 45° and a pour point below 41°F were

TABLE 2-3. Criteria Used in This Caps Review to Analyze Historical Opportunities for Mechanical Recovery, Dispersant Use, and *In Situ* Burning.

CRITERIA	MECHANICAL RECOVERY	DISPERSANT USE		*IN SITU* BURNING	
		EXISTING	EXPANDED	EXISTING	EXPANDED
API° gravity	17 to 45	17 to 45	17 to 45	17 to 45	17 to 45
Pour point	N/A	< 41°F	< 41°F	N/A	N/A
Wind speed	≤ 16 kts	≥ 7 kts	≥ 0	≤ 16 kts	≤ 16 kts
Water depth	N/A	≥ 65 ft	≥ 10 ft	N/A	N/A
Distance from shore	N/A	≥ 3 nmiles	≥ ¼ nmiles	≥ 3 nmiles	≥ ¼ nmiles

Note: Existing, greater than 3 nautical miles (nmiles) from shore; expanded, greater than ¼ nmile from shore; kts, knots.

TABLE 2-4. Spills Not Considered for Mechanical Recovery, Dispersant Use, and *In Situ* Burning, Shown by Criteria.

		NUMBER OF SPILLS ELIMINATED BY			
OIL REMOVAL METHOD	**CRITERIA LEVEL**	**OIL TYPE**	**DISTANCE FROM SHORE**	**WATER DEPTH**	**WIND SPEED**
Mechanical recovery	—	43	0	0	50
Dispersant use	Existing	44	152	117	14
	Expanded	44	84	48	0
In situ burning	Existing	43	151	0	50
	Expanded	43	84	0	50

Note: Spills may be counted in more than one cell because a spill might not be appropriate for a particular removal method for more than one reason. Existing, greater than 3 nautical miles (nmiles) from shore; expanded, greater than ¼ nmile from shore.

considered easily dispersible. Oils with an API° gravity in this range but with a pour point greater than 41°F were considered difficult to disperse, depending on whether the water temperature was greater than the pour point. All but one of the oils spilled in this historical analysis had an API gravity between 17° and 45° and a pour point below 41°F. The one spill in which the oil pour point was greater than 41°F was estimated conservatively to be non-dispersible because the water temperature at the spill scene was unknown. API° gravity and pour point, therefore, were the first two criteria used to assess potential dispersant effectiveness.

The third dispersant criterion, wind speed, translates into an approximation of sea state. The Beaufort Wind Scale (Table 2-1) shows the relationship between wind speed and corresponding sea state. Wind speed and water depth (the fourth criterion) were provided in MSIS reports or estimated as described earlier. Information regarding the distance from shore at which the spill occurred also was used for this purpose. As in the MSRC technical report (Kucklick and Aurand, 1995), this Caps review assumes that all necessary equipment and any required pre-authorizations would be in place so that dispersant operations could commence within 12 hours.

***In Situ* Burning.** In this review, criteria for evaluating open-water burning of oil, or *in situ* burning, came directly from the MSRC technical report (Kucklick and Aurand, 1995). The assumptions regarding chemical characteristics, distance from shore, and timely response discussed above for dispersant criteria were utilized for the *in situ* burning criteria as well. The assumptions regarding wind speed are identical to those for the mechanical recovery criteria because both methods rely on boom containment effectiveness, which is limited by sea state.

2.1.3 Results of Historical Analysis

The 231 nearshore, offshore, and open ocean oil spills were grouped as crude or refined oils. The majority of these spills involved refined products, with crude oil spills only a small percentage of the spill demographic. Two non-petroleum edible oil spills are included in the 231 spills within the analysis as “refined” oil. Analyzed oil spills were tallied by USCG

District (Figure 2-4) to give a geographic distribution of spill incidences (Figure 2-5). The bulk of all spills, both crude and refined, clearly occur in the Gulf of Mexico (8th District).

Potential Use of Mechanical Recovery. Mechanical recovery was eliminated as a potential oil removal technique in 88 of the 231 oil spills analyzed for one or more of the following reasons:

1. The type of oil discharged was not recoverable using mechanical methods.
2. The wind speed during the time of the spill exceeded 16 kts.

The specific number of spills ineligible for mechanical recovery are listed by criteria in Table 2-4.

According to the criteria in Table 2-3, mechanical recovery would have been appropriate in 61.9% (143 of 231) of the nearshore, offshore, and open ocean spills. Conditions were conducive to mechanical recovery in 15 of 16 crude oil spills and 128 of 215 refined oil spills. Figure 2-6 indicates the distribution of these spills by USCG District.

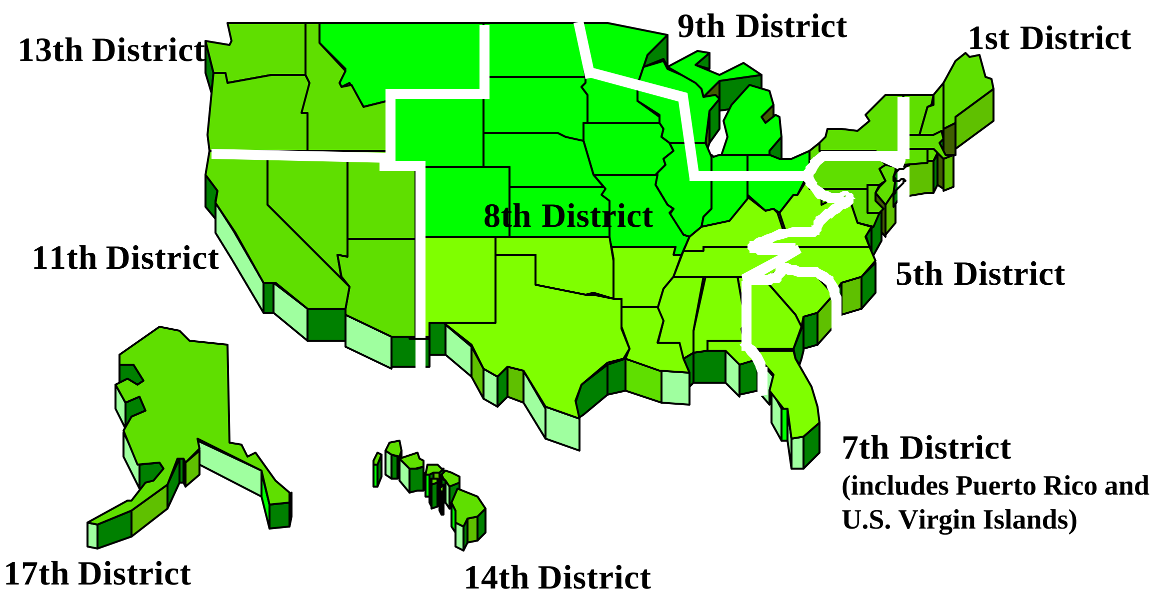

FIGURE 2-4. Delineation of USCG Districts. The 9th District, which includes the Great Lakes, is shown for completeness only. This historical analysis does not examine freshwater spills.

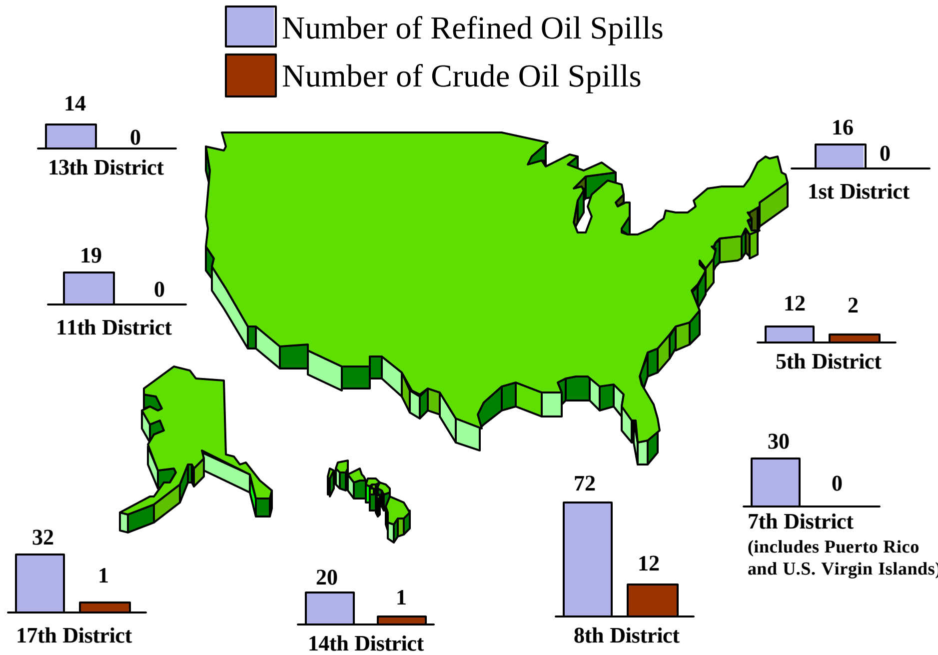

FIGURE 2-5. Distribution of Spills (n = 231) by USCG District to Analyze Historical Opportunities for Mechanical Recovery, Dispersant Use, and *In Situ* Burning, 1993–1998.

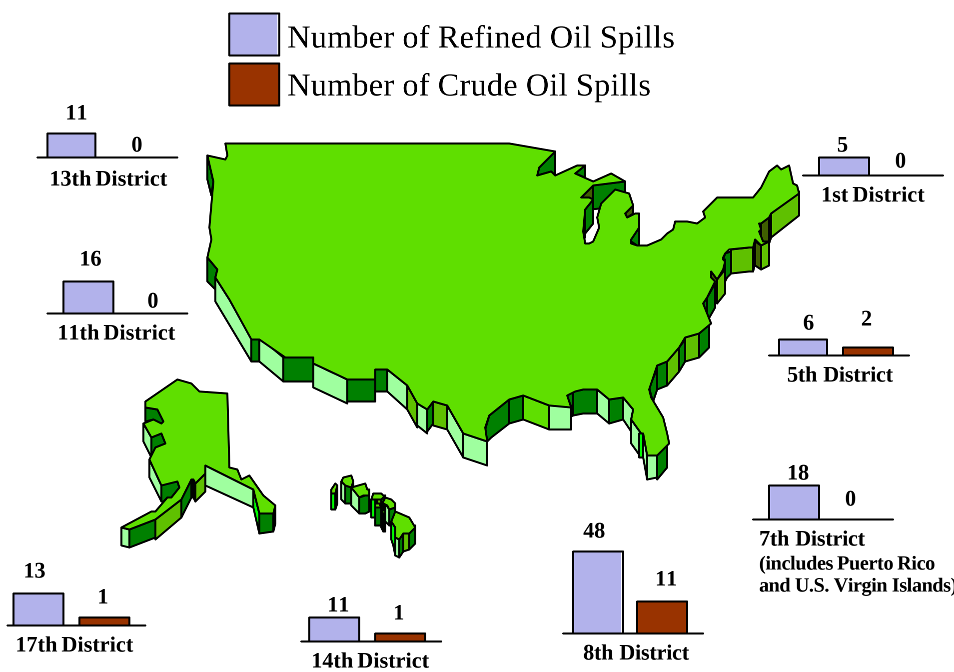

FIGURE 2-6. Distribution of Oil Spills (n = 143) by USCG District in Which Mechanical Recovery Might Have Been Used.

Potential Use of Dispersants. Dispersant application was excluded as a potential oil removal technique under existing criteria in 182 of the 231 oil spills analyzed for one or more of the following reasons (see Table 2-4 for the particular number of spills excluded for each reason):

1. The oil discharged was not dispersible.
2. The oil spill occurred less than 3 nmiles from shore.
3. The water depth at the oil spill scene was less than 65 ft.
4. The wind speed was less than 7 kts.

Under existing criteria, dispersant use may have been appropriate in 21.2% (49 of 231) of the oil spills analyzed. Evaluation shows that 4 of 16 crude oil spills and 45 of 215 refined oil spills demonstrate the potential for dispersability. Figure 2-7 indicates the distribution of these spills by USCG District.

Using the expanded criteria, potential dispersant use may have been appropriate in 44.6% of the oil spills in the historical analysis. Evaluation shows 8 of the 16 crude oil spills and 95 of 215 refined oil spills demonstrate the potential for dispersability (Figure 2-8).

Potential Use of *In Situ* Burning. Under the existing criteria, *in situ* burning was eliminated as a potential oil removal technique in 175 of the 231 oil spills analyzed for one or more of the following (see Table 2-4 for the number of spills eliminated for each reason):

1. The oil discharged was not burnable.
2. The oil spill occurred less than 3 nmiles from shore.
3. The wind speed exceeded 16 kts.

In situ burning was a viable removal option in 24.2% (56 of 231) of the oil spills included in the historical analysis under the existing criteria. Evaluation shows 7 of 16 crude oil spills and 49 of 215 refined oil spills having conditions amenable to burning methods. Figure 2-9 indicates the distribution of these spills by USCG District.

The percentage of candidate spills increased to 39% (90 of 231) for spills under the expanded criteria. Evaluation shows 11 of 16 crude spills and 79 of 215 refined oil spills as potential candidates for *in situ* burning in combination with mechanical recovery (Figure 2-10).

2.2 CONCLUSIONS

How often do opportunities for mechanical recovery, dispersant use, or* in situ *burning occur?

- Analyzing historical opportunities between 1993 and 1998 shows 231 oil spills greater than 1,000 gals in nearshore, offshore, and open ocean areas over 69 months (January 1993 to September 1998), or about once every 9 days.

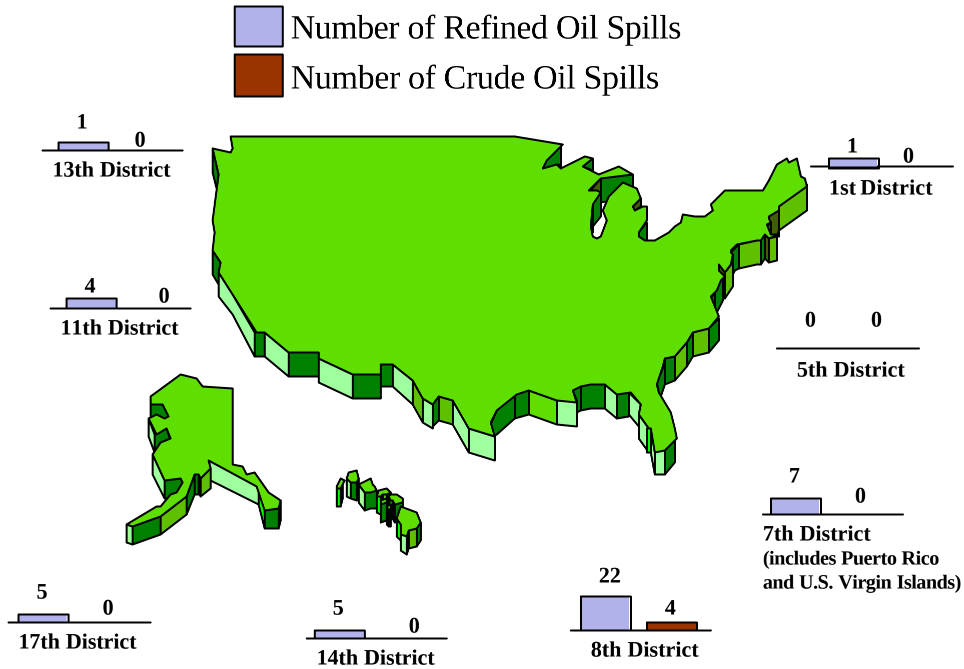

FIGURE 2-7. Distribution of Oil Spills (n = 49) by USCG District in Which Dispersants Might Have Been Used Under the Existing Criteria—Greater Than 3 Nautical Miles (Nmiles) from Shore.

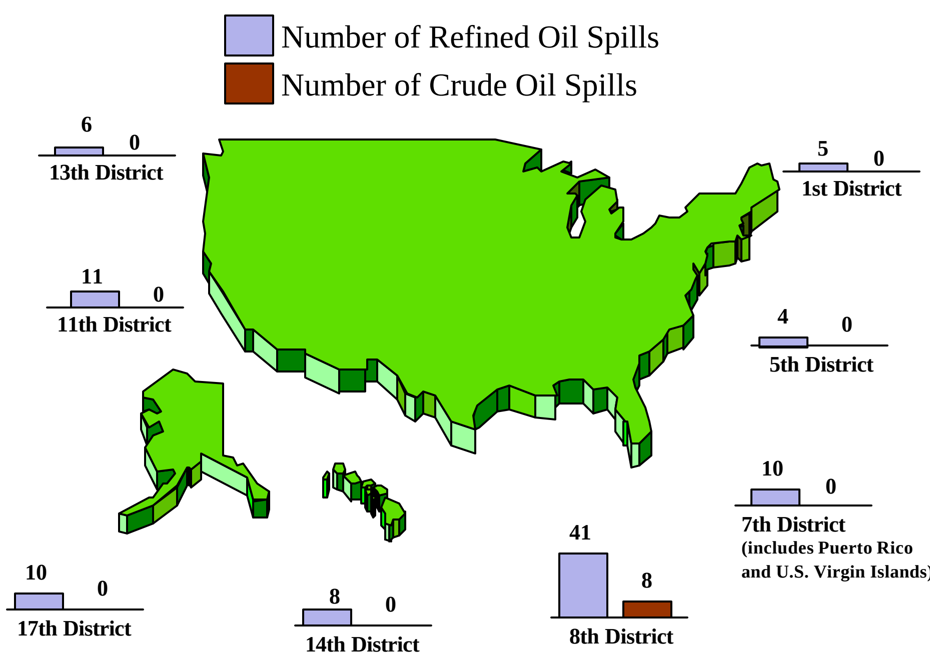

FIGURE 2-8. Distribution of Oil Spills (n = 103) by USCG District in Which Dispersants Might Have Been Used Under the Expanded Criteria—Greater Than ¼ Nautical Mile (Nmile) from Shore.

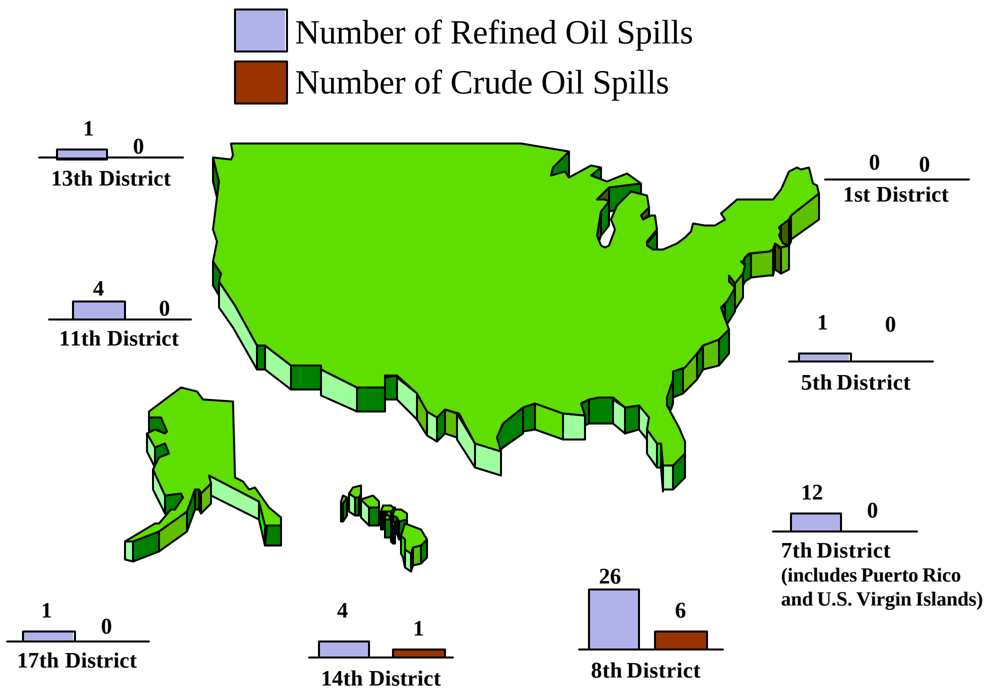

FIGURE 2-9. Distribution of Oil Spills (n = 56) by USCG District in Which *In Situ* Burning Might Have Been Used Under the Existing Criteria—Greater Than 3 Nautical Miles (Nmiles) from Shore.

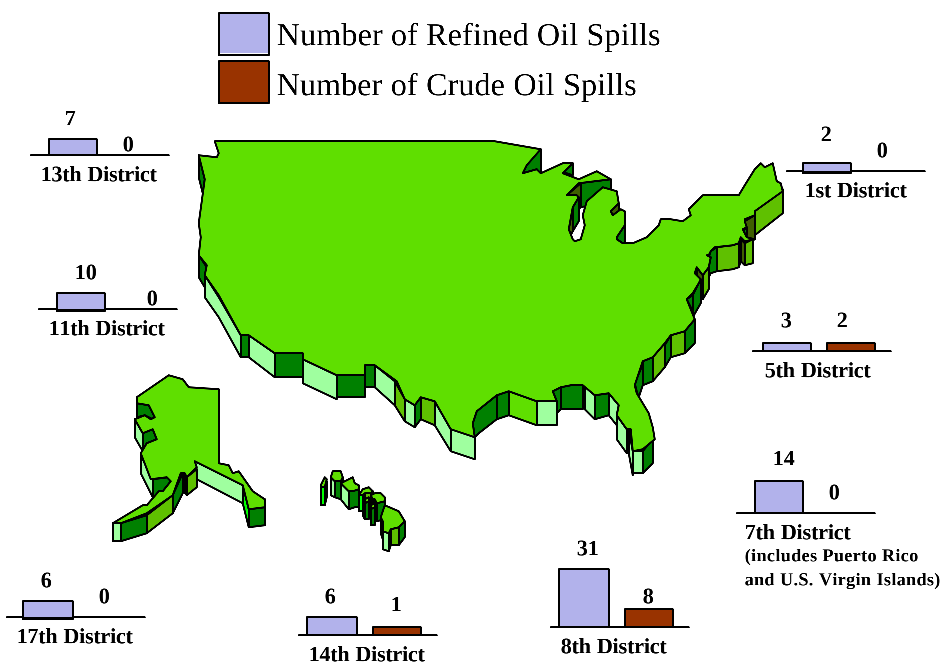

FIGURE 2-10. Distribution of Oil Spills (n = 90) by USCG District in Which *In Situ* Burning Might Have Been Used Under the Expanded Criteria—Greater Than ¼ Nautical Mile (Nmile) from Shore.

- The majority of these spills (61.9%) had potential for mechanical recovery.
- Under existing criteria (greater than 3nmiles from shore), 20–25% of the spills were potential candidates for dispersant use and *in situ* burning.
- Of the 231 spills in the historical analysis, there were 87 spills in which mechanical recovery was the only viable option for oil removal and 12 spills in which dispersant use was the only option.
- There were no spills in which *in situ* burning was the only option. Clearly, mechanical recovery is most often the removal option available in spill response, but dispersant use and *in situ* burning might have made a significant impact on an additional 13% of the spill occurrences.
- Using the expanded criteria (greater than ¼ nmile from shore) for dispersants and *in situ* burning, the percentage of candidate spills for these oil removal techniques increases greatly. Opportunities for dispersant use double from 49 to 103, so that nearly 45% of the 231 spills analyzed might have benefited from dispersant use. The number of opportunities for *in situ* burning increases from 56 to 90, 40% of 231 spills.

Is there a general geographic distribution of opportunities for mechanical recovery, dispersant use, or* in situ *burning?

- Of the 231 spills examined, 49.4% occurred in the Gulf of Mexico and waters east of Florida. The 17th District (Alaska) had the next greatest number of incidents with 33 spills (14.3% of 231 spills).
- The 8th District ranks highest in percentage of potentially dispersible spills (26 of 84 spills, or 31%) under the existing criteria. The 7th District has the largest number of potential opportunities for *in situ* burning (12 of 30 spills, or 40.0%) under the existing criteria. Using the expanded criteria, the 11th District has the greatest percentage of both dispersant use and *in situ* burning candidates—58% (11 of 19 spills) and 53% (10 of 19 spills), respectively.